

Panel 2: X-ray transport and ablation physics

This panel will examine the physics that drives the “1D” hydrodynamics of NIC implosions, namely the x-ray transport in an indirect-drive hohlraum and the ablation of the capsule. Of particular interest are the coupling efficiency and drive pressure history of the capsule. The data show there are physics issues that need to be understood further.

NIC capsule implosions show discrepancies between models employing the nominal x-ray drive and observed global hydrodynamic properties such as velocity history, bang time and shell thickness. Inferred stagnation pressures are lower than predicted, suggesting that extra entropy is injected in the capsule hot spot that inhibits compression, possibly due to the global hydrodynamics, such as an extra shock. These discrepancies affect every aspect of the implosion; symmetry, stability, and mix. Understanding these effects and developing predictive models will allow us to design more optimal implosions. Sources of these discrepancies include the possibility that the x-ray drive seen by the capsule differs in unexpected ways from that observed through the laser entrance hole (LEH), and that the ablator response to the drive through material properties (equation of state or opacity) differs from the models.

The drive observed through the entrance hole with the Dante diagnostic is expected to be different from that seen by the capsule. Designers use integrated calculations of the hohlraum and capsule to connect them, but this depends on calculations of the distributions of hot, x-ray-emitting and cooler, absorbing matter that might shadow the capsule. As mentioned in the scope for panel 1, mix of gas fill with the ablated hohlraum wall may alter those distributions. Recent data suggest that while models may match the measured DANTE signal they over-predict LEH closure, suggesting the actual radiation temperatures through the LEH and on the capsule are lower than simulated.

The ablator material properties play a critical role in capsule performance. Much of the NIC tuning campaign has been focused on adjusting for uncertainties in these properties. Different equation of state and opacity models as well as potential non-Local Thermodynamic Equilibrium (NLTE) properties of the polymer ablator remain of active interest. Modeling with the Cretin NLTE code shows that carbon in the low-density blow off can have an ionization state significantly higher than LTE predictions due to the high photon flux. The ionization energy of K-shell electrons of carbon is comparable to the characteristic photon energy of the incident x-ray spectrum as the radiation temperature rises through the third and fourth pulses. In that regime, K-shell physics plays an important part in the energy balance, so differences in ionization state or level populations can affect ablator performance. Initial NLTE models suggest as much as half of the timing discrepancy in capsule implosion time could be due to NLTE effects, although a robust NLTE model remains a work in progress. Some of the models show an undesirable double-ablation front structure during part of the drive, eventually collapsing into a single front that could launch an additional shock.

This panel will explore ways to improve understanding of the radiation transport to the ablation front and the way the ablator responds to that incident radiation flux. We will consider modeling improvements and experiments that could help unravel the source of discrepancies between models and NIC implosions.